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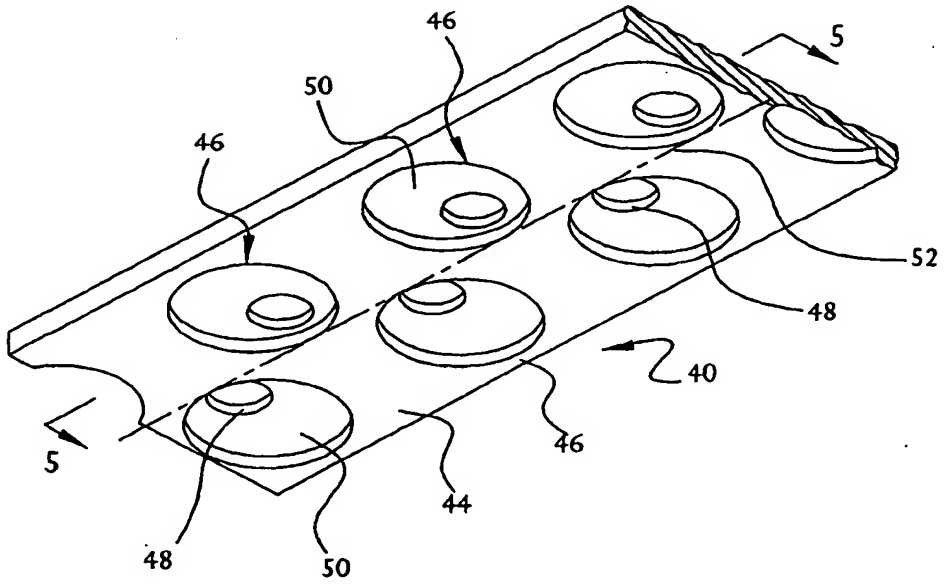

(57) Abstract

The present invention provides an improved vacuum assist transfer belt (40). The belt includes a vacuum aperture (50) that provides an increased surface area that engages a box blank being transferred through a folding device. By providing an aperture (50) having a larger surface area engaging the box blank, the stronger seal between the transfer belt (40) and the box blank, the stronger seal between the transfer belt (40) and the box blank may be obtained. The improved belt allows a variety of sized box blanks to be transferred using the same vacuum device.

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VACUUM ASSIST TRANSFER BELT

Field of the Invention

The present invention is directed to an endless belt for moving materials. More particularly, the present invention is directed to an endless belt for use in conjunction with a vacuum device for moving box blanks in the manufacture of corrugated boxes.

Background of the Invention

The manufacture of corrugated boxes requires scoring, cutting, folding, and gluing a corrugated box blank. This process is typically carried out by a machine known as a flexo folder gluer. One of the last operations in fabricating the corrugated blank into a knockdown box is the folding process. During the folding process, the box blank is transported through a folder portion of the flexo folder gluer to perform a 0° to 180° final fold. A common means of transporting the box blank through the folder portion is a vacuum assist transfer belt. In general, there is an endless belt including a plurality of through holes and a vacuum associated with the belt that provides a suction effect on box blanks through the holes. The suction effect is intended to maintain the box blank in a fixed position relative to the belt and prevent slippage as the belt moves past an arrangement of folding rods.

Figure 1 illustrates a portion of a conventional vacuum assist transfer belt. This belt 10 includes a plurality of through holes 12. These holes 12 are uniformly aligned along the longitudinal center line 14 with the belt 10. The holes 12 have a uniform diameter and they extend through the belt 10.

Figure 2 illustrates a portion of another conventional vacuum assist transfer belt. This belt 16 includes a plurality of holes 18. The holes 18 are configured in two rows offset equally from the longitudinal center line 14. In addition, one row of holes 18a is shifted along the center line 14 relative to the other row of holes 18b in an amount equal to one-half the distance between adjacent holes in the direction of the center line 14. In other words, the row of holes 18a is shifted relative to the row of holes 18b an amount equal to one-half the distance **d**. This provides an alternating effect from side to side of the center line as one moves along the center line.

Figure 3 illustrates a conventional vacuum assist transfer belt 16 in conjunction with a conventional vacuum box, generally indicated by the reference numeral 20. Also illustrated is a box blank 22 that is being transferred by the belt 16 to engage and be folded by a folding rod 24. The vacuum box 20 includes a vacuum slot 26 having a width V that leads to an interior vacuum chamber 28. Air is drawn out of the vacuum chamber 28 through a vacuum duct 30, generally along a path indicated by arrow P.

The surface area of the box blank 22 that is subject to the suction effect via the through holes 18 is effectively limited to that corresponding to the area of the through holes, as defined by their diameters. In addition, the width of the vacuum slot 26 also limits the suction effect on box blank 22. As such, the conventional vacuum assist transfer belt can only provide a limited amount of holding force to keep the box blank flush against the belt during transport in the folding section of the flexo folder gluer.

Because the through holes 18 are maintained within the width V of the vacuum slot 26, only a limited amount of the box blank's surface area is acted upon by the vacuum box 20. Typically, flexo folder gluers operate on blanks of different width. As wider box blanks are fed to the flexo folder gluer and into the folder section, there is less and less relative surface area of the box blank that is acted upon by the vacuum box 20. As a result, the outer portions of the box blank 22 tend to pull away from the belt 16 as the box blank 22 travels into the folder

section and is engaged by the folding rods 24. In addition, as the position of the folding rods is changed to accommodate different box blanks, the theoretical fold line 32 changes position relative to the vacuum box 20. This change in position also has an effect on the forces applied to the box blank 22 and may cause the box blank 22 to pull away from the belt as the box blank 22 travels through the folder section. For either of the those reasons, as the box blank 22 pulls away from the belt 16, the box blank 22 will tend to fold along a line other than the desired theoretical fold line 32. In addition, if the box blank 22 pulls from the belt 16 enough, the suction seal between the box blank 22 and the belt 16 will be broken and the box blank 22 could potentially fall from the belt, and cause a shutdown in the line or other problems.

Summary of the Invention

The present invention provides a vacuum assist transfer belt which overcomes the drawbacks of known vacuum assist belts. The belt according to the invention includes an endless band having an exterior box blank engagement surface and an interior vacuum surface. The belt includes a plurality of vacuum apertures. Each of the vacuum apertures includes an interior portion that extends from the interior surface into the band and an exterior portion that extends from the exterior surface into the band. The interior portion and the exterior portion form a continuous opening through the band.

The present invention provides an inexpensive but effective way to increase the holding force between the transfer belt and the box blank.

The present invention provides a vacuum assist transfer belt having improved holding properties.

Brief Description of the Figures

For the purpose of illustrating the invention, there is shown in the drawings forms which are presently preferred; it being understood, however, that

this invention is not limited to the precise arrangements and instrumentalities shown.

Figure 1 is an exterior plan view of a portion of a conventional vacuum assist transfer belt.

Figure 2 is an exterior plan view of a portion of another conventional vacuum assist transfer belt.

Figure 3 is a sectional view of a vacuum box in a typical flexo folder gluer in cooperation with the vacuum assist transfer belt of Figure 2.

Figure 4 is a perspective view of a portion of an embodiment of a vacuum assist transfer belt according to the present invention.

Figure 5 is a sectional view of the belt of Figure 4, taken along lines 5-5.

Figure 6 is a sectional view of a vacuum in a typical flexo folder gluer in cooperation with a vacuum assist transfer belt according to the present invention.

Figure 7 is perspective view of a portion of a second embodiment of a vacuum assist transfer belt according to the present invention.

Figure 8 is a sectional view of the belt of Figure 7, taken along lines 8-8.

Figure 9 is a perspective view of a portion of a third embodiment of a vacuum assist transfer belt according to the present invention.

Figure 10 is a sectional view of the belt of Figure 9, taken along lines 10-10.

Figure 11 is a perspective view of a portion of a fourth embodiment of a vacuum assist transfer belt according to the present invention.

Figure 12 is a sectional view of a portion of a fifth embodiment of a vacuum assist transfer belt according to the present invention.

Figure 13 is a sectional view of a portion of a sixth embodiment of a vacuum assist transfer belt according to the present invention.

Figure 14 is a bottom view of a portion of a seventh embodiment of a vacuum assist transfer belt according to the present invention.

Detailed Description of the Invention

In the drawings, where like numerals indicate like elements, there is shown a vacuum assist transfer belt or band 40 according to the present invention. With reference to Figures 4 and 5, a preferred embodiment of a transfer belt 40 of the present invention is illustrated. The belt 40 includes an interior vacuum surface 42 and an exterior box blank engagement surface 44. The belt 40 has a thickness T. A plurality of apertures 46 are formed in the belt 40. Each of the apertures 46 comprises an interior portion 48 and an exterior portion 50. The interior portion 48 extends from the interior surface 42 into the belt 40. The exterior portion 50 extends from the exterior surface 44 into the belt 40. The interior portion 48 and the exterior portion 50 form a continuous opening through the belt 40. As illustrated in Figure 4, the interior portion 48 and the exterior portion 50 are both circular in shape. The exterior portion 50 has a greater diameter than the interior portion 48.

With reference to Figure 6, the belt 40 is illustrated in operative cooperation with a conventional vacuum box 20. The vacuum box 20 operates as discussed above. In order to provide the maximum holding force, all of the interior portion 48 of the apertures 46 must be positioned entirely within the width V defined by a vacuum slot 26. Since the exterior portion 50 has a greater diameter than the interior portion 48, the exterior portion 50 extends further from a center line 52 and provides a surface area that engages the box blank 22 which is significantly greater than conventional belts. In this embodiment, the interior portion 48 and the exterior portion 50 meet halfway between the interior surface 42 and the exterior surface 44.

As illustrated in Figure 4, the plurality of apertures 46 is divided into two rows. The rows are on opposite sides of the center line 52. Furthermore, the

two rows are shifted relative to each other in the direction of the center line 52. This results in an alternating configuration along the center line 52.

With reference to Figure 6, the belt 40 provides improved holding forces between the box blank 22 and the belt 40. During operation of the flexo folder gluer. the vacuum box 20 draws air through the exterior portion 50 and the interior portion 48 into the slot 26 and out the chamber 28 and into the duct 30. As the vacuum box 20 draws the air through the apertures 46, the box blank 22 is drawn to the belt 40, preferably forming a stable seal between the box blank 22 and the belt 40. As the belt 40 moves through the folder portion of the flexo folder gluer, the folding rod 24 engages and folds the box blank 22 along theoretical fold line 32.

Because the exterior portion 50 extends farther to the side of the belt 40 than the interior portion 48, the effects of the vacuum are stronger at portions of the box blank near the folding rod. This improves the accuracy of the folds along the theoretical fold line 32.

Furthermore, because the exterior portion 50 has a greater surface area than the interior portion 48, a greater portion of box blank 22 is subjected to the effects of the drawing force of the vacuum box 20. This provides a greater overall holding force between the box blank 22 and the belt 40.

Referring to Figures 7 and 8, another embodiment of a transfer belt 40′ according to the present invention is illustrated. The only difference between this embodiment and the first embodiment lies in the shape of the exterior portion 50′. In this embodiment, the exterior portion 50′ presents a rectangular shape and has a uniform depth.

Referring to Figures 9 and 10, a third embodiment of a transfer belt 40″ of the present invention is illustrated. The difference between this embodiment and the first and second embodiments lies in the shape of the exterior portion 50″. In this embodiment, the exterior portion 50" presents a three-dimensional triangular shape and has a uniform depth.

Referring to Figure 11, a fourth embodiment of a transfer belt 40'" of the present invention is illustrated. This embodiment presents two similar vacuum apertures. The first type of aperture 60a includes a first interior portion 62 identical to the aforementioned interior portion and an exterior portion 64 having a square box shape . These apertures 60a differ from the others in that the interior portions 62 are centered on the center line 66 and the exterior portions 64 are centered on the interior portions 62. The second type of aperture 68 is very similar to the apertures discussed with respect to the first three embodiments. However, these apertures include an exterior portion 70 having a generally square three-dimensional shape. Furthermore, the second type of aperture 68 is separated into two rows, one row on each side of the center line 66, where the rows are positioned to present offsetting apertures 68.

Referring to Figure 12, a fifth embodiment of a transfer belt 40"" of the present invention is illustrated. This embodiment shows the belt 40"" having a first portion 48 extending from the interior surface 42 having a uniform depth and a second portion 72 extending from the exterior surface 44 having a depth that increases linearly from the intersection between the first and second portions and the exterior surface 44 such that the surface area of the second portion 72 at the exterior surface 44 is greater than the surface area of the first portion 48 at the interior surface 42.

Referring to Figure 13, a sixth embodiment of a transfer belt 40""' of the present invention is illustrated. This embodiment shows the belt 40""' having a first opening 74 at the interior surface 42 and a second opening 76 at the exterior surface 44 and a continuous hollow 78 connecting the first opening 74 and the second opening 76. The hollow 78 has a depth that increases linearly from the first opening 74 to the second opening 76 such that the surface area of the second opening 76 is greater than the surface area of the first opening 74.

Referring to Figure 14, a seventh embodiment of a transfer belt 40"""" of the present invention is illustrated. This embodiment shows the belt 40"""" having apertures 46 identical to the apertures described with reference to the

embodiment illustrated in Figures 4 and 5. Specifically, the apertures 46 include an inner portion 48 and an outer portion 50. However, in the embodiment illustrated in Figure 14, the inner portions 48 are centered on a longitudinal axis 52 and the outer portions 50 are positioned slightly to the side of the longitudinal axis 52 in an alternating side to side manner yet still encompassing the inner portion 48.

Referring to Figures 5, 8, 10, 12, 13, and 14 it does not matter what shape the through opening between the interior surface 42 and the exterior surface 44 takes in cross section, as long as the opening at the exterior surface has a surface area greater than the opening at the interior surface. In other words, the cross sectional shape of the hollow between the exterior and interior opening may be stepped, linear, doglegged, etc.

All the disclosed embodiments are illustrated and described as having only a single shape for the exterior or interior portion cutouts, it is within the scope of the present invention to intermix different shaped exterior portions. For example, the exterior portions may intermix rectangular and circular shapes.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

CLAIMS

1. A vacuum assist transfer belt, comprising:

a continuous belt including an exterior engagement surface and an interior vacuum surface and a thickness defined by the exterior and the interior surfaces;

a first plurality of openings in the belt extending from the interior surface into the belt for a distance less than the thickness of the belt; and

a second plurality of openings in the belt extending from the exterior surface into the belt, each one of the second plurality of openings contiguous with and in communication with one of the first plurality of openings forming a plurality of openings completely through the belt;

the second openings having an area at the exterior surface greater than the area of the first openings at the interior surface.

2. A vacuum assist transfer belt as recited in claim 1, further comprising a longitudinal axis and wherein the edges of the second plurality of openings extend farther from the longitudinal axis than the edges of the first plurality of openings.

3. A vacuum assist transfer belt as recited in claim 2, wherein each of the second plurality of openings are centered about a point farther from the longitudinal axis than the first plurality of openings.

4. A vacuum assist transfer belt as recited in claim 2, wherein the through openings are offset from the longitudinal axis forming two rows.

5. A vacuum assist transfer belt as recited in claim 2, wherein all of the first plurality of openings are entirely within a predetermined distance from the longitudinal axis.

6. A vacuum assist transfer belt as recited in claim 1, wherein all of the first plurality of openings are entirely within a width defined by a vacuum slot.

7. A vacuum assist transfer belt as recited in claim 2, wherein the through openings are offset from the longitudinal axis forming two alternating rows.

8. A vacuum assist transfer belt as recited in claim 2, wherein the plurality of through opening are divided into two rows, each row positioned to one side of the longitudinal axis.

9. A vacuum assist transfer belt as recited in claim 8, wherein one of the rows of through openings is shifted along the longitudinal axis an amount equal to half the distance between adjacent through openings in the direction of the longitudinal axis.

10. A vacuum assist transfer belt as recited in claim 1, wherein the second plurality of openings have a circular shape.

11. A vacuum assist transfer belt as recited in claim 1, wherein the second plurality of openings have a rectangular shape.

12. A vacuum assist transfer belt as recited in claim 1, wherein the second plurality of openings have a triangular shape.

13. A vacuum assist transfer belt, comprising:

an endless band including an exterior engagement surface and an interior vacuum surface; and

a plurality of vacuum apertures, each of the apertures including an interior portion extending from the interior surface into the band and an exterior portion extending from the exterior surface into the band, the interior portion and the exterior portion forming a continuous opening through the band;

the exterior portions having an area at the exterior surface greater than the area of the interior portions at the interior surface.

14. A vacuum assist transfer belt as recited in claim 13, further comprising a longitudinal axis and wherein the exterior portions extend farther in a lateral direction from the longitudinal axis than the interior portions.

15. A vacuum assist transfer belt as recited in claim 13, wherein the plurality of vacuum apertures are spaced uniformly along a longitudinal axis of the band.

16. A vacuum assist transfer belt as recited in claim 15, wherein the plurality of vacuum apertures are divided into two rows, each row located to one side of the longitudinal axis.

17. A vacuum assist transfer belt as recited in claim 16, wherein one of the rows of apertures is shifted along the longitudinal axis an amount equal to half the distance between adjacent apertures in the direction of the longitudinal axis.

18. A vacuum assist transfer belt as recited in claim 13, wherein the apertures are positioned in an alternating fashion along a longitudinal axis of the band.

19. A vacuum assist transfer belt as recited in claim 13, wherein the interior portion of each of the apertures is entirely within a predetermined distance from the longitudinal axis.

20. A vacuum assist transfer belt as recited in claim 13, wherein the exterior portions have a circular shape.

21. A vacuum assist transfer belt as recited in claim 13, wherein the exterior portions have rectangular shape.

22. A vacuum assist transfer belt as recited in claim 13, wherein the exterior portions have a triangular shape.

23. A vacuum assist transfer belt, comprising:

an endless band including an exterior engagement surface and an interior vacuum surface; and

a plurality of vacuum apertures in the band, each of the apertures having an opening at the interior surface and an opening at the exterior surface and a continuous hollow in the band between the interior surface opening and the exterior surface opening, the exterior surface opening having a greater area than the interior surface opening.

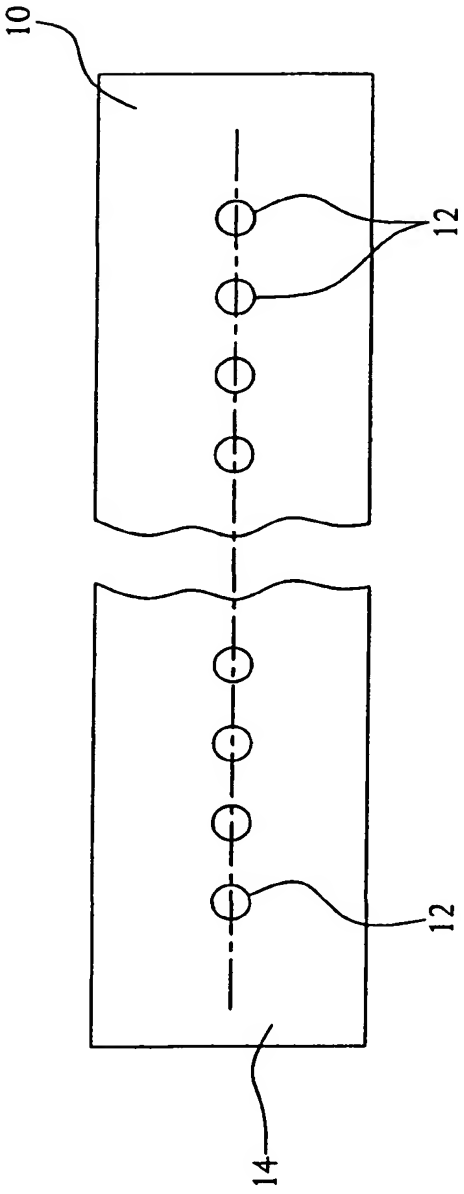


FIG. 1

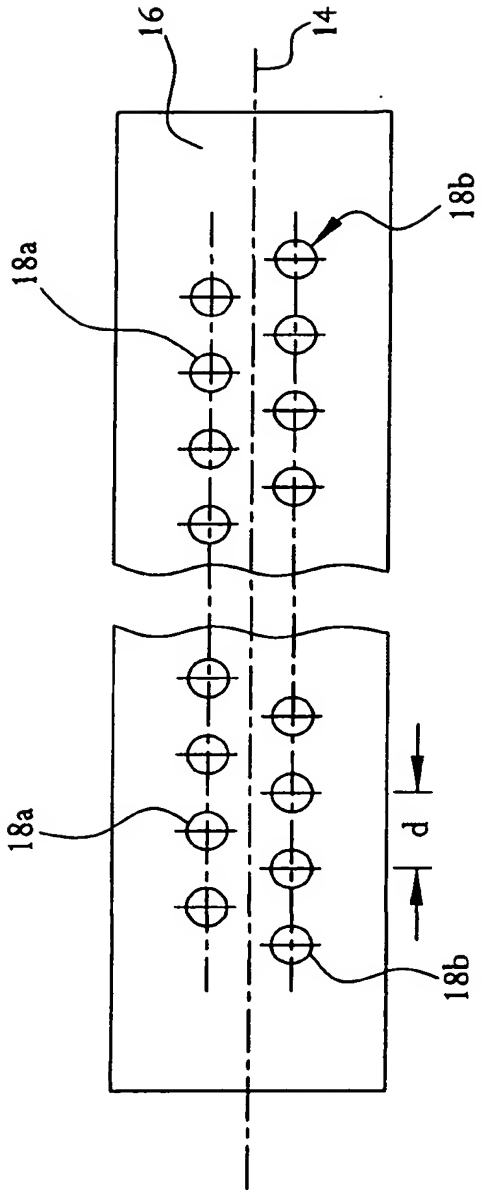
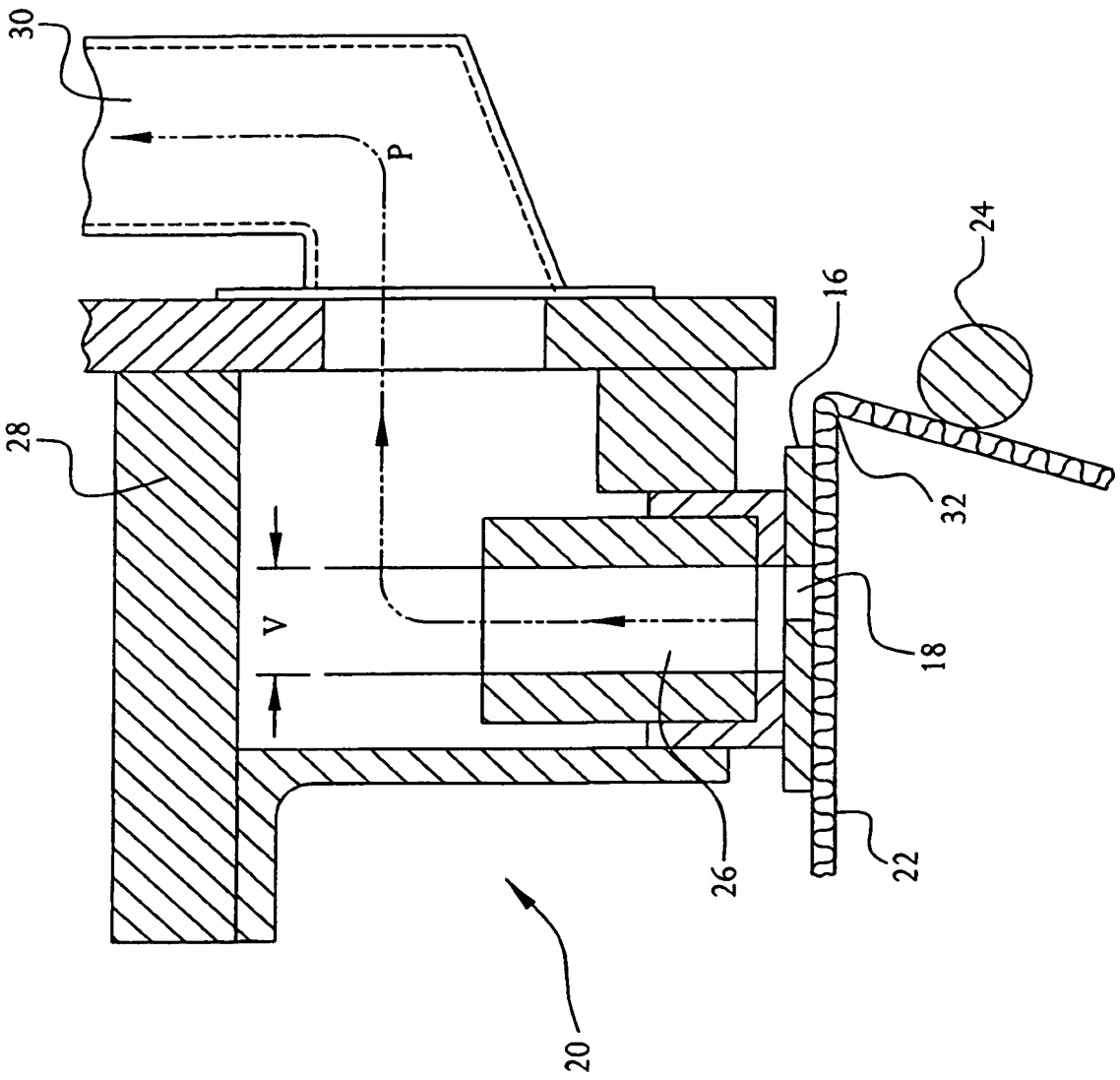


FIG. 2

FIG. 3



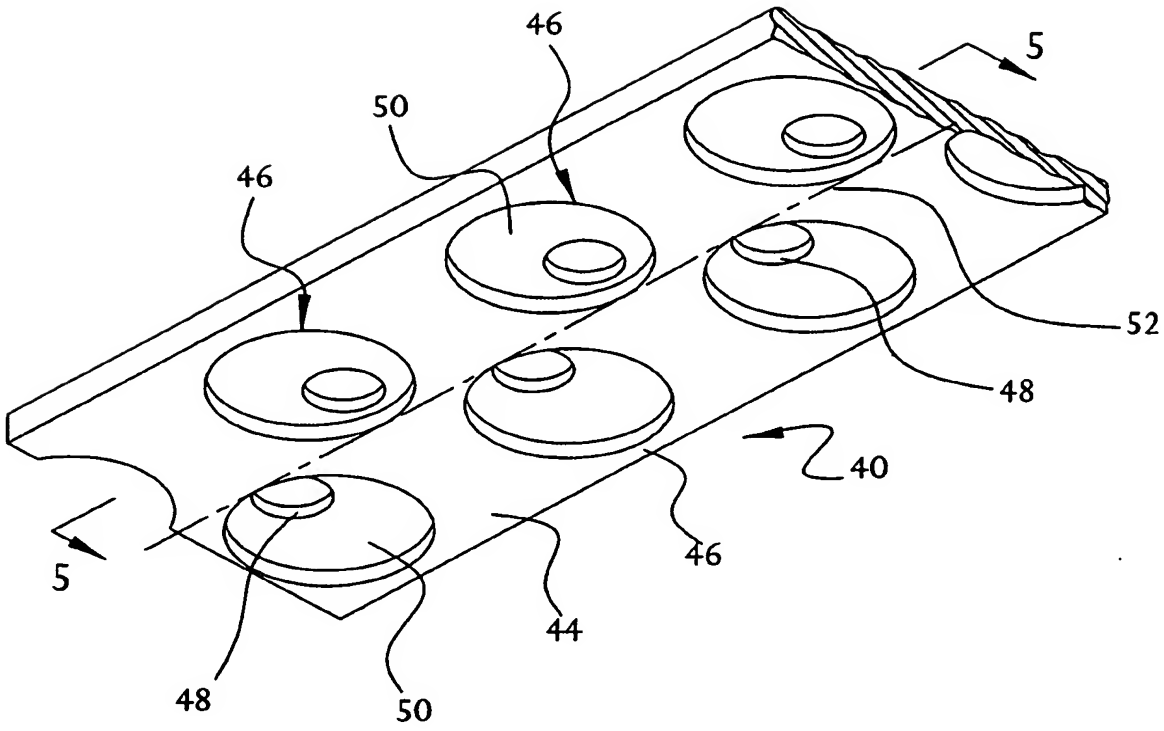


FIG. 4

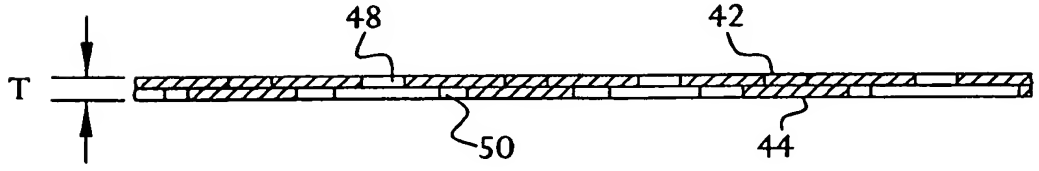
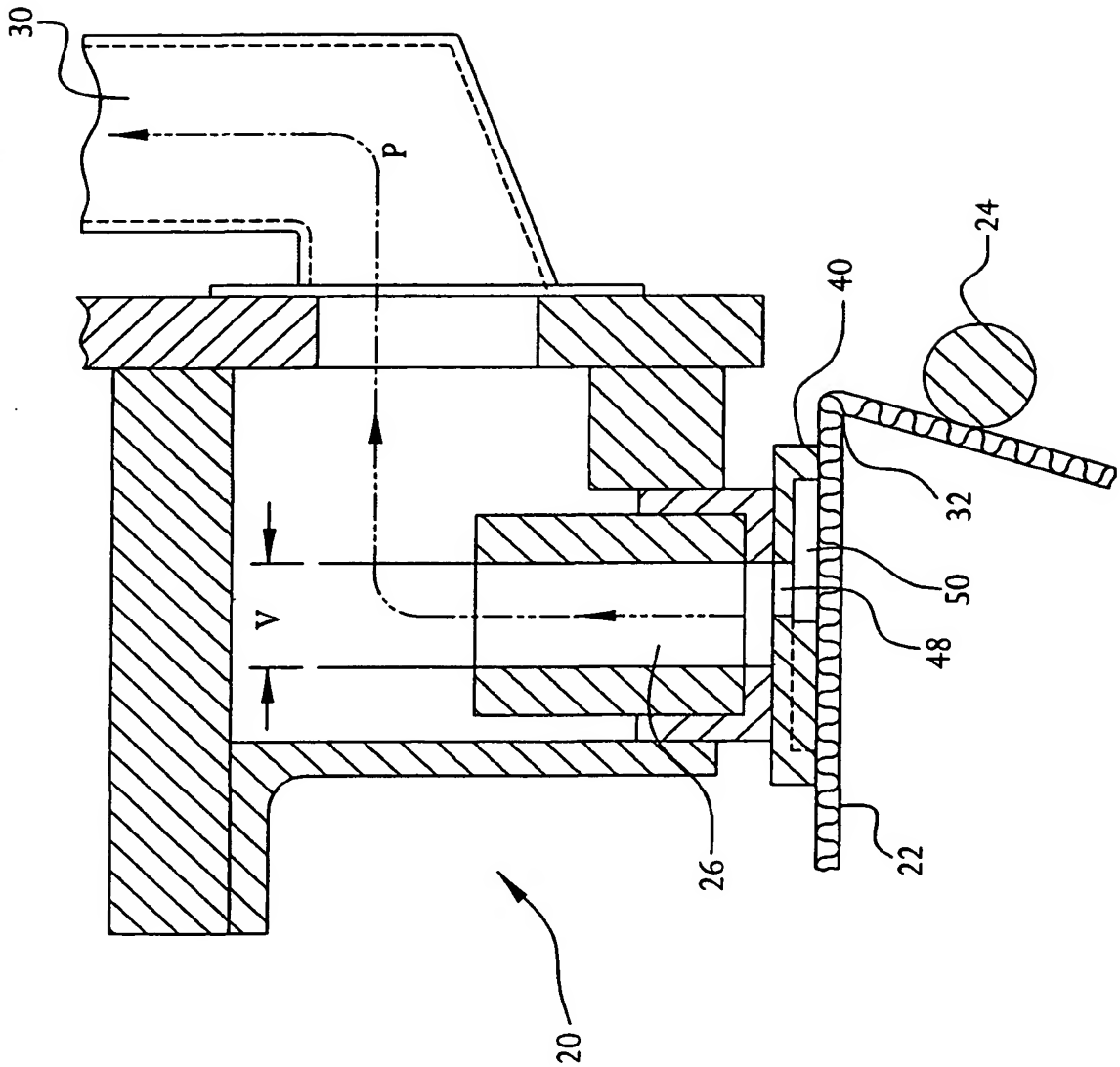


FIG. 5

FIG. 6



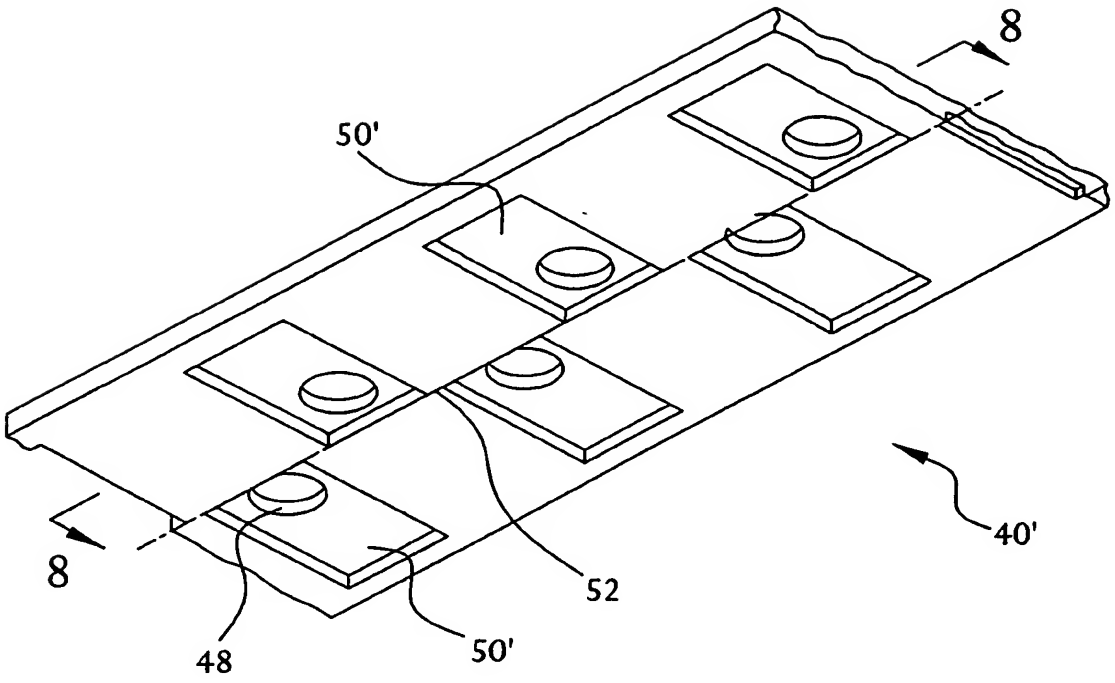


FIG. 7

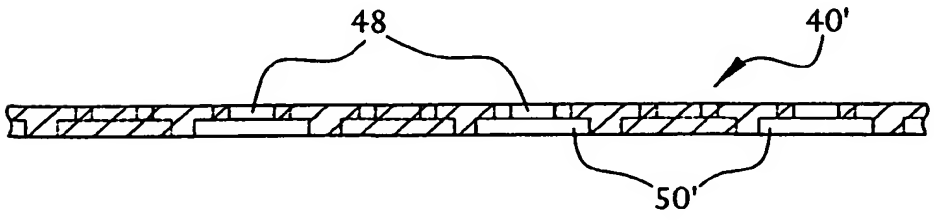


FIG. 8

FIG. 9

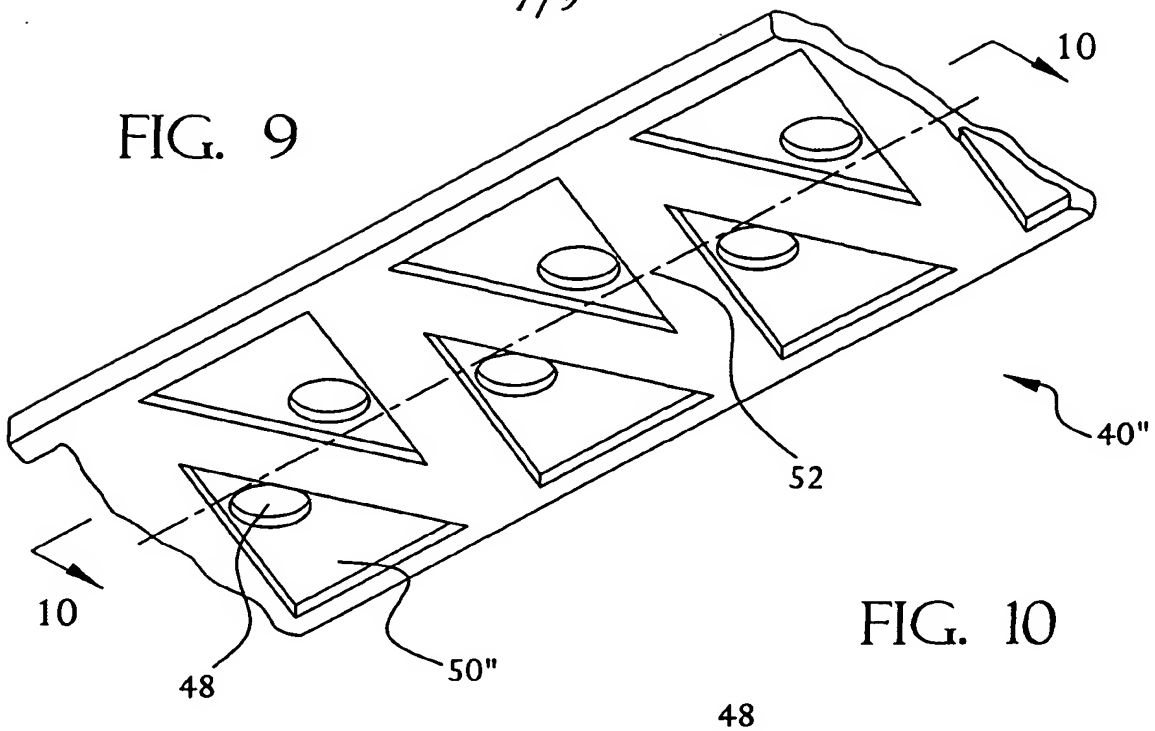
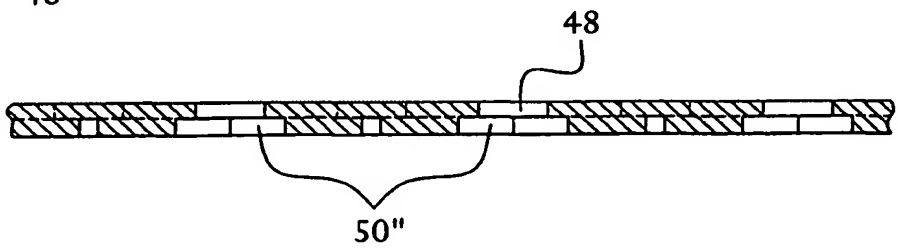


FIG. 10



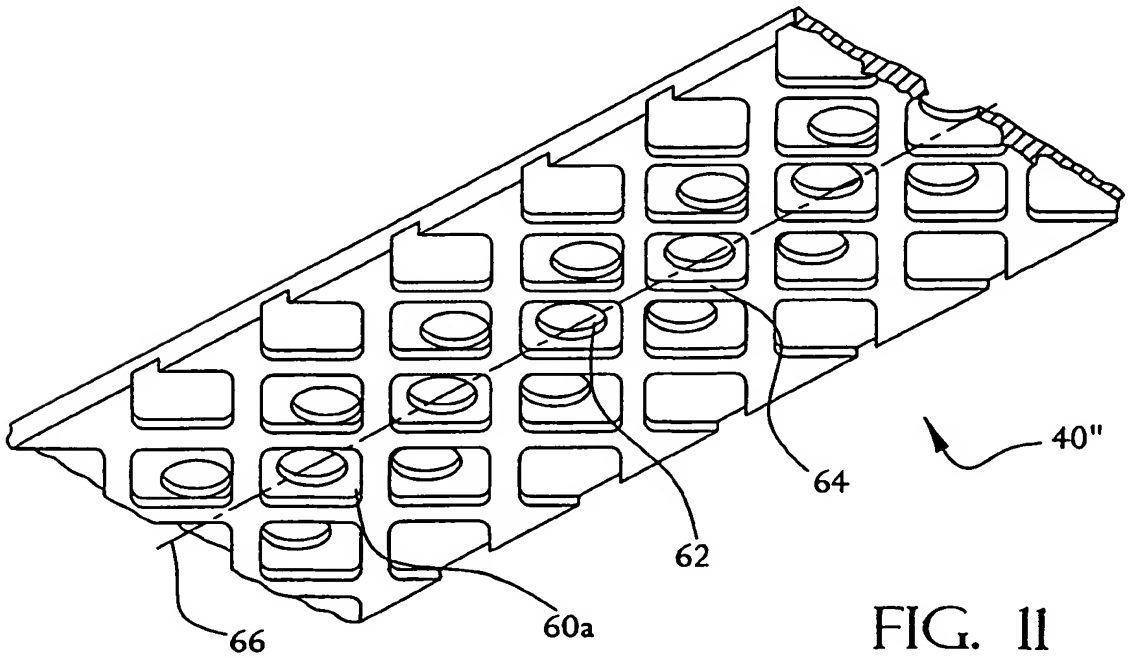


FIG. 11

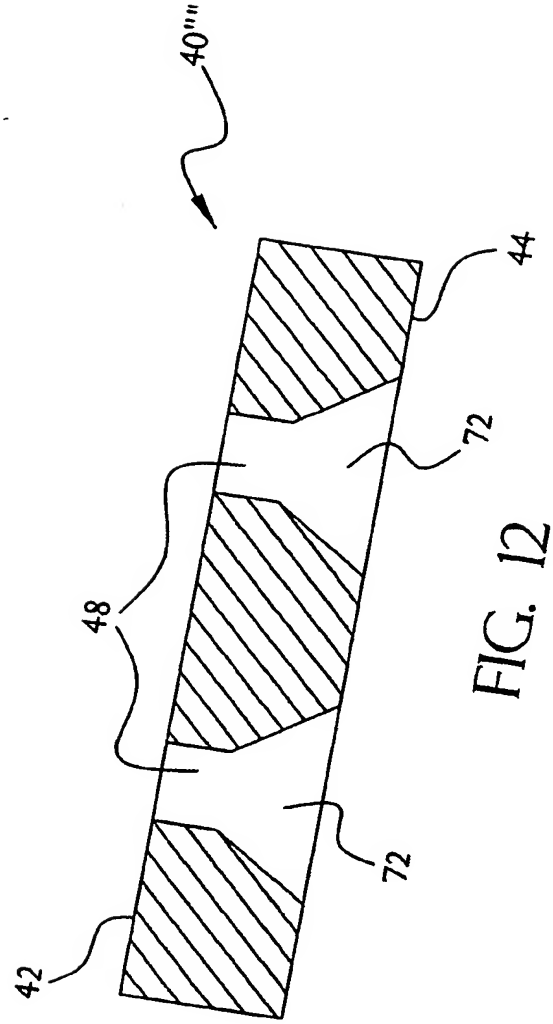


FIG. 12

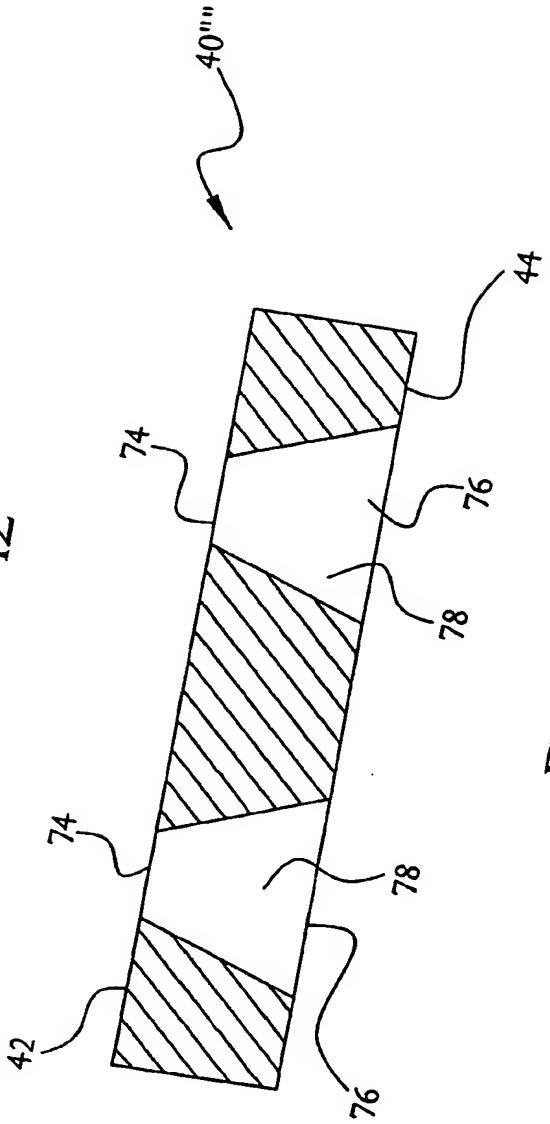


FIG. 13

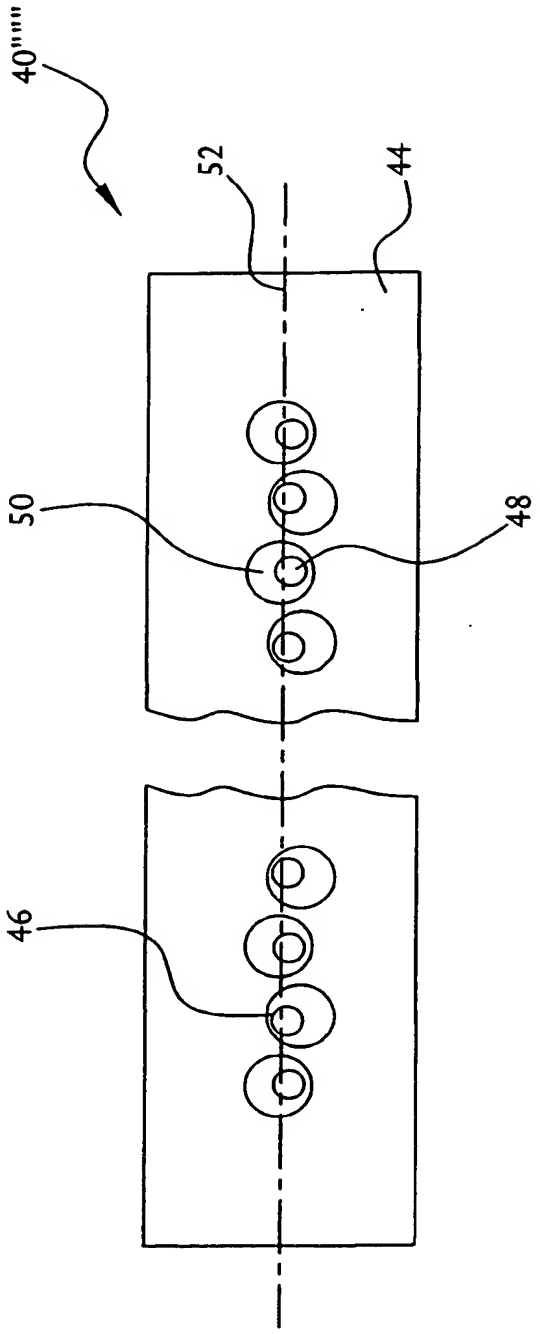


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/28924

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B65G 13/02
US CL :198/689.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 198/689.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,182,998 A (PETERSON) 11 MAY 1965 (11/05/65), see entire document	1-23
A	US 3,708,058 A (KALVEN) 02 JANUARY 1973 (02/01/73), see entire document	1-23

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search 10 MARCH 2000	Date of mailing of the international search report 11 APR 2000
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